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Phenology Symposium 2019.
Abstracts

Ola Langvall (Ed.)

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences
Unit for Field-based Forest Research

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Phenology Symposium 2019

This report contain abstracts from the presentations, orally or on poster, at the Phenology Symposium 2019, held by the Swedish National Phenology Network (SWE-NPN) and the Biodiversity and Ecosystem services in a Changing Climate (BECC).

The symposium is held in Uppsala February 4, 2019, at the Swedish University of Agricultural Sciences campus Ultuna,

Organizing committee consists of

– Ola Langvall, Swedish University of Agricultural Sciences, researcher and coordinator of the Swedish National Phenology Network

– Åslög Dahl, Gothenburg University, researcher in BECC

– Jacob Johansson, Lund University, researcher in BECC

Program

9:30 **Registration** and coffee (poster presentations)

10:00 **Introduction**

Session 1

10:05 **Introductory speech**
The benefit from phenological observations when tracking the effects of a changed climate in nature, from a stakeholder's perspective.
Ola Langvall (Swedish National Phenology Network) and Henrik Josefsson (Länsstyrelsen Örebro län)

10:30 Artportalen – a species reporting system for Swedish animals and plants.
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10:50 Trends of first flowering dates of hazel (Corylus avellana L.) under warming.
Tochia Ting (National Taiwan University)

11:10 The course of the annual life cycle of bees may be selected to match local floral resources.
Åslög Dahl (Gothenburg University, BECC)

11:30 Understanding phenological strategies in plants through studies on genetically defined barley mutants.
Mats Hansson (Lund University, BECC)

11:50 **Lunch** (poster presentations and mingle)

Session 2

12:30 **Key-note speech**
Growing and enjoying wine in a changing climate
Kimberly Nicholas (Lund University)

13:15 Long-term standardized forest phenology in Sweden, a climate change indicator and used in forestry.
Ola Langvall (Swedish University of Agricultural Sciences)

13:35 Annual variation of berry production in south-central Sweden and its bottom-up effects on brown bears.
Anne Hertel (Senckenberg Biodiversity and Climate Research Centre)

14:00 **"Speed dating"** - exploring the current and future use and demand for phenology deliverables

15:15 **Coffee break** (poster presentations and mingle)

15:30 **Presentation** of "results" from speed dating

16:00 **Closure** of symposium

“Speed dating”

How can we create science–stakeholder win-win situations in phenology research and environmental monitoring.

The idea of arranging speed dating is to explore the current and future use and demand for phenology deliverables and how collaboration between observers, scientists and stakeholders can be established and fruitful.

Participants meet in smaller groups and discuss certain topics (Table 1). At the end, all will gather and “results” from the discussions will be presented.

Table 1. Meeting points and their topics. Some thoughts of what can be included in the discussions are added.

Blue meeting point

Research projects and funding

- Inspiring examples of research projects involving phenology and stakeholders.
- Ideas for projects/applications involving phenology to VR/Formas.
- Visionary, grand, international and long-term projects - think big!
- How could the phenology network support projects and applications?
- How can we generate resources for stakeholder-science projects apart from funding agencies?

Yellow meeting point

Need for data and indicators

- What kind of phenology data should we collect (=is useful). Wish for anything!
- New indicators of climate change built on phenology observations.
- What is on the horizon - big data and artificial intelligence?
- Science-stakeholder collaboration around monitoring.

Black meeting point

Data collection and quality

- Balance between Citizen science data and professionally collected data
- How to assure a certain quality?
- How to maintain long-term collection of observations?
- How can we harness the power of tech - drones, mobile apps, phenocams, remote sensing?

Red meeting point

Stakeholder-science collaboration and communication

- How can scientists and stakeholders collaborate – best practice?
- How can the phenology network facilitate collaboration?
- What wishes for collaboration do you have (scientist vs. stakeholder or vice versa)?
- What can you offer in collaborations?
- What kind of phenology models are useful for you?
- How can we reach out in social media, tv, radio and other channels?

Abstracts

The benefit from phenological observations when tracking the effects of a changed climate in nature, from a stakeholder's perspective.

Ola Langvall, the Swedish National Phenology Network, and Henrik Josefsson, Länsstyrelsen i Örebro län, Sweden

Phenological shifts, i.e. changes in the timing of seasonal events, are well-documented effects of climate change, with potentially large impact on nature and society including biodiversity conservation, spread of invasive species and conditions for growth, pests or frost damage in agriculture and forestry, as well as on human health (allergies). The symposium will be framing questions especially interesting to stakeholders in public service and researchers that focus on monitoring and modelling the impact of climate change on nature, or e.g. modelling seasonal growth patterns.

Phenology observations are collected in Sweden in many ways, e.g. visually by citizen scientists and professionals, and remotely with phenocams and satellites. These can be compared to observations made in a Swedish phenology network operating between 1873 and the 1920's, to discover ecological shifts due to climate change. Swedish data can also be combined by using a common ontology, with other data sources in Europe (PEP725 network) and globally (e.g. through the ISB Phenology Commission).

Phenology data are demanded and useful in many ways, e.g. in environmental monitoring, forest management, recreational guidance to the public and research. As an example, we show how the Swedish Environmental Agency use plant observations collected by the Swedish Nature's calendar, to create an indicator of how today's climate affect the length of the growing season, compared to the data we have from 100 years ago, for the monitoring of the Swedish Environmental Objectives that we have decided on.

Finally, also some examples where phenology plays an active role for the tourist industry, for researchers modelling climate change effects and growth, and how new products based on phenology data can be produced, to meet the demands from stakeholders, in collaborative work.

Artportalen – a species reporting system for Swedish animals and plants.

Stephen Coulson, Artdatabanken, Sweden

Artportalen (Swedish Species Observation System) is a web based reporting platform for observations of Swedish animals and plants for all who will report, download data, exchange knowledge and contribute to Swedish environmental management. The infrastructure is hosted by SLU ArtDatabanken (The Swedish Species Information Centre, SSIC, at SLU) and currently contains >67,000,000 georeferenced observations, along with 1,300,000 images, video or sound, of some 32,000 species in Sweden.

Greater than 90% of these observations originate from an environmentally knowledgeable general public. When targeted or surveillance monitoring programs are not available, data collected by the public can be an excellent alternative source of information. In addition to reports from the general public, an increasing number of Swedish governmental authorities and agencies are also using the platform to store regional and local species inventories collected by standardized scientific methods.

As the comprehensive data set enables both spatial and temporal analysis, the Artportalen records are now frequently used by county and municipality councils in Sweden as a principle biodiversity resource in environmental planning and decision making. Moreover, the Artportalen data are increasingly used by scientists for phenology, species distribution modelling, and scenario modelling.

To inform science or conservation, qualified infrastructure systems that are designed to collect accurate and usable data in a flexible and transparent way need to be continually developed. Citizen Science approaches also provide a unique way for scientists and educationalists to engage with the public whose participation allows for cost-efficient collection of data.

Trends of first flowering dates of hazel (Corylus avellana L.) under warming.

Tochia Ting and Biing T. Guan, National Taiwan University, Taiwan

Analyzing phenological data assists researchers to assess the impacts of warming on the ecosystem. This is an important task because phenological shifts might change the relationship between interactive species. Consequently, the process and structure of the ecosystem would be influenced. These results are connected with the social and economic activity of us. However, this task is not easy because phenological data are usually nonstationary and nonlinear.

We applied a posteriori methods to analyze hazel's first flowering date (FFD) anomaly (Corylus avellana L.) in Germany from PEP 725 Database. The first method is ensemble empirical mode decomposition and the second is maximum entropy bootstrap. The former can extract the underlying trends in the data. The latter can generate resamples without losing the time structure of the original data. These methods allow the trends be revealed with statistical meaning.

The results showed that the FFD anomaly trend of hazel was advancing, which was corresponding with the rising temperature trend. In addition, the FFD anomaly trend started to advance after around 1965. However, warming did not happen until around 1978. The advancing FFD anomaly trend was found 13-year earlier than we can claim warming happened.

We provide two possible reasons to explain the results. The first is, beside the rising temperature, there are other driving forces for hazel to flower. The second is the different properties between the FFD and the temperature data. FFD is an extreme phenophase among a complete flowering event while the temperature data are the average results during a period. This difference implies FFD is more variable than temperature. To improve future phenological study, we suggest to thoroughly record and analyze the complete process of a phenological event.

Keywords: First flowering date, hazel, trend, warming, ensemble empirical mode decomposition, maximum entropy bootstrap

The course of the annual life cycle of bees may be selected to match local floral resources.

Åslög Dahl, Gothenburg University and BECC, Sweden

The access to high-quality local floral resources is likely to exert a strong selection pressure on the annual life cycle of pollinating bees. Bees rely more or less exclusively on pollen for proteins, sterols, and micronutrients, and use nectar as a carbohydrate source. Lack of pollen, or a pollen diet lacking essential nutrients, has an adverse effect on offspring growth, adult bee size, and overall survivorship.

I will present a new EU/Interreg project comparing the performance of local races of the dark Nordic honeybee *Apis mellifera subsp. mellifera* with the imported *A. m. subsp. ligustica* and the hybrid race Buckfast, at a number of different latitudes in Sweden and Norway. The foreign breeds have to a large degree replaced the native honeybees during the last half-century. However, the latter are still conserved in a number of places, e g at Nordens Ark in Bohuslän.

0nly a few studies have investigated the possibility that adaption to the local flora took place in honeybees, but, as I will discuss, these indeed indicate the occurrence of ecotype formation. Their observations, and hopefully, the results of the new project, will provide a knowledge base to estimate the risk for possible mismatch between plants and pollinators and to develop bee and floral conservation strategies. They may also contribute ideas and methods for the study of wild bees, which probably are even more vulnerable to the current environmental changes.

Understanding phenological strategies in plants through studies on genetically defined barley mutants.

Mats Hansson, Lund University and BECC, Sweden

The timing of flowering is important for the reproductive success of plants. The plant should grow large during the spring and summer in order to produce a lot of new seeds in the autumn. If the plant waits too long with the transition from the vegetative to the reproductive phase it might be trapped by bad weather conditions in the end of the season and no seeds are able to mature. On the other hand, an early transition may result in a small size at flowering and too few seeds being produced compared to competing individuals. Thus, the transition from vegetative to reproductive growth is one of the most important events in the life cycle of flowering plants, which needs to be optimized with respect to geographic location and environmental conditions, and which is responding to cues like daylength and temperature.

We work with four genetically defined barley mutants lines; mat-a.8, -b.7, -c.19 and -e.18, which were induced in the cultivar Bonus more than 50 years ago. The mat-a and mat-e lines are daylength neutral, i.e. they do not adjust their start of flowering in response to changes in daylength. The lines mat-b and mat-c respond to changes in daylength but not to changes in temperature. During standard farming conditions in Sweden, mutant mat-a.8 is always earliest. However, when grown at other latitudes this is not always the case.

In collaboration with Dr. Jacob Johansson, we try to understand the contribution of the Mat-a, -b, -c and -e genes to the optimal timing of switching between growth and reproduction, and try to predict how defined genes will have an impact on phenological adaptations in future climates. Since the molecular network regulating timing of flowering is likely to be common to all plants, we expect that knowledge gained from barley will help us to understand phenological strategies in Helianthemum oelandicum (ölandssolvända) and Crepis tectorum (klofibbla).

Growing and enjoying wine in a changing climate.

Kimberly Nicholas, Lund University Centre for Sustainability Studies, Sweden

Grapevine harvest records have been used to reconstruct climate for hundreds of years, and the adaptation of winegrapes to climate is known and appreciated by wine enthusiasts worldwide. I will share some of our latest research on how winegrape phenology, yields, and quality are affected by climate change, predictions for the future, and examples of winegrowers leading the way in climate adaptation and mitigation.

Long-term standardized forest and berry phenology in Sweden, a climate change indicator and used in forestry.

Ola Langvall and Mikaell Ottosson Löfvenius, Swedish University of Agricultural Sciences, Sweden

Standard assessments of phenology, by monitoring the dates when specific changes of phases are seen in nature has valuable benefits and is often promoted for citizen science monitoring of phenology. However, such data may have rather low precision and does not describe gradual changes well.

Many of the important phenology traits that can be seen in forest trees and forest berries change over an extended period of time. Thus, monitoring of the gradual transition is therefore important, to resolve timing of the tree status to other traits, e.g. susceptibility to nocturnal frosts, insects and fungi, and berries as food source to animals.

Swedish Experimental Forests have for more than a decade intensely monitored the start of the growing season of Scots pine, Norway spruce, downy and silver birch by weekly assessments of the growth of apical and branch buds and the elongation of shoots. Furthermore, the development and abundance of bilberries and lingonberries during the growing season, from flowering until the last berry has disappeared, has been monitored. By using a quantitative method for monitoring, i.e. measuring the length of bud/shoot and counting berries, respectively, the development may easily be interpolated between assessment dates and the average development and the inter-annual variation be assessed for each trait.

Results show e.g. an 8 and 13 day delay of the active growth period of pine, from latitude 57° to 61° and 64°, respectively. The Swedish Forest Agency has based recommendations of origins of plant material and on possible susceptibility to fungal decease during the growing process. Ripe berries reach maximum numbers after approx. 2 weeks after ripening begins, decrease to 50% during the following month, and almost all berries are gone after 2 months. Berry data has been used in research and official statistics.

Annual variation of berry production in south-central Sweden and its bottom-up effects on brown bears.

Anne Hertel, Senckenberg Biodiversity and Climate Research Centre, Germany

Bears often rely on seasonally restricted soft or hard mast to accumulate resources for winter hibernation. Studies from North America and Japan suggest that bears respond to years of mast crop failure by increasing movement activity and ranging farther, with a demonstrated increase in human-wildlife conflicts.

In southcentral Sweden, brown bears primarily feed on bilberry (Vaccinium myrtillus) during hyperphagia. We used an eleven-year time series to evaluate the effect of temperature and snow on annual variation in berry production and how this variation affected bear life history traits and behavior.

We found marked interannual variation in berry production that we could attribute in part to temperature during plant dormancy and flowering, and to precipitation during fruit ripening. Autumn weights of female bears and spring weights of yearling bears increased with bilberry production and initially light-weight females profited from high bilberry production and were more likely to produce a litter. We, however, did not detect any changes in bear movement, activity, or home range behavior in relation to berry production. Also, bears rarely visited human settlements and the number of visits did not increase in relation to shortage of natural food.

Though our results demonstrate that brown bears in Sweden are food limited like bears in North America or Japan, our results suggest that the drivers of conflict between bears and humans differ among ecosystems. An explanation could be the different spatial distribution of food resources or differences in the magnitude of variation in food abundance among years which might help to explain the low number of human-bear conflicts in Sweden.

Adaptation of reproductive phenology to climate change and resource competition. *(poster)*

Magnus Lindh, Stockholm University, Sweden

Understanding which traits are favourable in different environments is a key objective in evolutionary biology and imperative to predict how organisms are affected by, and might adapt to, changes in climate and land use. Classic theory predicts how the timing of reproduction optimally balances vegetative and reproductive growth with seasonal resource distributions, but does traditionally not take interactions within or between species into account. Here we explore how natural selection on reproductive timing is modulated by exploitative competition. In this evolutionary game resource availability depends on the strategies employed by the competitors.

We focus on annual organisms and in particular bumblebees which compete for seasonally variable resources, where population declines have been linked to phenology. We find that the evolutionarily stable strategy (ESS) reproduction time is earlier than the optimum predicted by classic theory (ignoring competition), but later than the strategy maximizing population size. This implies that phenological adaptation to environmental changes may cause population declines. Further, resource competition affects both the strength and direction of selection of reproduction time in generic scenarios of climate change. For example, the ESS reproduction time is only weakly affected by longer seasons, in contrasts to classic theory which predicts a delayed optimum. We show that neither the ESS nor the optimum reproduction time changes in parallel with shifting seasonal resource peaks, but rather at a slower rate. Hence a growing asynchrony between peak flowering times and timing of reproduction, which is often interpreted as a phenological mismatch, may be an adaptive response in this system.

Using drones to investigate arctic phenology *(poster)*

Mattias Siewert, Umeå University, Sweden

We study Arctic vegetation changes and phenology using true color and multispectral data from a drone at four study areas near Abisko, northern Sweden. The study areas have an extent of 15-21 ha. They are dominated by tundra vegetation and located at or above the treeline. We monitor in approximately two to three week intervals over the growing season from May to late September. We measure the normalized difference vegetation index (NDVI) with the drone and at 30 randomly distributed ground control points using handheld NDVI measurements. During each time measurement interval, we also take photos of the ground plots to monitor phenological stages. The drone data in combination with ground photographs can be used to investigate phenological transitions at individual plots and at landscape scale. We investigate to what extent micro habitats influence differing phenology. We hope to reveal dominating factors for differences in phenology at landscape scale, such as micro-topography, snow cover and redistribution, micro-climate or hydrological factors.

Long term analyses of European beech (Fagus sylvatica L.) phenology in Western Carpathians (Central Europe). *(poster)*

Martin Kubov, Technical University in Zvolen, Slovakia

The paper examines the results of phenological research on common beech (Fagus sylvatica L.) during a period of 24 years (1995–2018) in the submontane beech forest of central Slovakia (Inner Western Carpathians). We focused on bud-burst, leaf unfolding and leaf colouring.

Temporal analysis indicated that the mean monthly air temperature increased, especially from April to August. An extraordinary increase of air temperature in March and April, mostly in the last decade, was detected. The precipitation from May to August varied considerably, but in the range of the long-term mean value.

During the study period, the mean/earliest/latest onset of the bud-burst of common beech was observed on the 109th /101st/120th day of the year (DOY), respectively. As for leaf unfolding 10% and 50% (LU 10 and LU 50), we found the mean/earliest/latest onset on the 113th/103rd/122nd DOY and on the 117th/108th/124th DOY, respectively. The mean/earliest/latest onset of leaf colouring 10% (LC 10) and 50% (LC 50) started on the 273nd/262nd/288th DOY and on 286th/276 th/298th, respectively. A medium degree of negative correlation was found between air temperature and spring plant development (LU 50). In contrast, for both the cumulative temperature and precipitation, we found very low correlation with autumnal leaf phenology. The vegetation period of common beech lasted for 170 days on average (min/max were 155/183 days).

Trend analysis revealed the shifts in onset of the phenophases. An earlier onset of spring phenophases by 8 days/24 years was observed. On the other hand, autumnal phenophases delayed by 10 days, so vegetation period of examined tree species extended by 18 days during the study period.